L. A. Veremejchik,
Institution of education "Belarussian state technological university", Minsk, Republic of Belarus

RESOURCE AND ENERGY SAVING IN GREENHOUSE VEGETABLE FARMING IN BELARUS

The introduction of resource and energy saving low-volume technology for the cultivation of vegetables in greenhouse combines of the Republic of Belarus makes it possible to ensure economic and environmental safety of production activities. The main advantages of this technology are the reduction of specific energy consumption by 30–40 % in the structure of production costs and increase of the productivity of vegetables by more than 3 times. Computer management of vegetable crops with the use of drip irrigation, localization of nutrients in a limited amount of substrate, optimization of the nutritional regimen, taking into account the requirements of plants in different phases of growth and development, contributes to increased productivity, reduced fertilizer losses, improved quality of vegetable products, and reduces the environmental burden of production.

Vegetable growing of protected soil is one of the most complex, capital-intensive and energy-intensive spheres of agriculture. Currently the greenhouse complex of the Republic of Belarus includes 24 the largest greenhouse farms, where annually more than 100 thousand tons of vegetables are produced, or 30–35 % of the total volume of their production in agricultural and other organizations of the republic. The area of modern winter greenhouses was more than 244 hectares, in which more than 11 kg of vegetables per inhabitant of the country in 2016. In general, the volume of vegetable production has doubled, the average yield is more than 40 kg/m^2, and advanced greenhouses receive more than 60 kg/m^2 in recent years. The list of crops grown in winter greenhouses: cucumbers, tomatoes, aubergines, peppers, salads, arugula, basil, celery, dill, parsley, coriander, sorrel and other green cultures has significantly expanded – more than 15 items.

The acute problem for the country's greenhouse complexes is the price of energy carriers: natural gas, electric and thermal energy. Taking into account that in the cost of production the specific gravity of heat carriers occupies more than 55 %, the issues of energy and resource saving in vegetable growing of protected soil acquire special urgency. According to the latest data, mineral fertilizers (approximately 17–20 %) and energy resources (natural gas – more than 35 %), the

cumulative share of which is more than 55 %, account for the prevailing share of production of vegetable crops in the protected soil of the republic.

In accordance with this, the economic and environmental safety of the production activities of greenhouse complexes is ensured by the introduction of energy and resource saving low-volume technology. The main advantages of this technology are a 30–40 % reduction in the specific energy costs in the structure of production costs, primarily due to the technological effect – increasing the yield of vegetables by 2–3.5 and more times [1].

The introduction of a modern low-volume technology for the cultivation of vegetable crops in greenhouse combines of the republic began in 1995 and was carried out by purchasing equipment from a well-known Dutch firm Agrotech-Didam (Netherlands) on the basis of tender selection. In the formation of irrigation systems, design and construction of greenhouse complexes, Agrotech-Didam is one of the leading places in the world, which has been confirmed in agro-enterprises of a number of regions of Belarus.

The use of artificial substrates in a low-volume culture involves a number of advantages: substrates are extremely simple, their use is fully automated. They reduce (15–30 times) the volume of the root environment (substrate) in comparison with the ground. The need for transportation, steaming, disinfection of soil soils and the implementation of laborious work on the preparation of expensive soil mixtures is excluded, which significantly reduces energy and labor costs in comparison with the use of soils [1].

The principal possibility of import substitution of mineral wool substrates with inorganic bulk materials from building materials of domestic production: perlite, agloporite, expanded clay – for tomato growing in resource-saving low-volume technology is established for the conditions of the Republic of Belarus. These substrates are much cheaper than mineral wool, easily accessible, hygienic in work, easy to utilize, do not require currency means for purchase, they can be continuously used for a long period (4–5 or more years). In addition, the environmental problem associated with the need to recycle mineral wool is being solved, since there are no

enterprises in the republic for processing such materials. Building materials remain suitable for subsequent use, they can be sold to construction organizations for 30–40 % of the original price.

It should be borne in mind that the regulatory and technological base created on the basis of the results of visual, chemical and morpho-biometric diagnostics is widely used in the management of the nutrition of vegetable plants in a low-volume culture. Modeling of technological processes should correspond to the establishment of appropriate requirements and the optimal relationship between substrates and crops grown on them. The system of tomato nutrition, which provides for the differentiation of nutrient solutions and irrigation doses depending on the type of mineral substrates, which provides for increased yields and improved fruit quality, as well as cost savings for the purchase of mineral fertilizers, has been developed and recommended for use in domestic rootenvironment [1].

Computer management of vegetable crops with the use of drip irrigation, localization of nutrients in a limited amount of substrate, optimization of the nutritional regimen, taking into account the requirements of plants in different phases of growth and development, contributes to increased productivity, reduced fertilizer losses, improved quality of vegetable products, and reduces the environmental burden of production. The quality control of the used water and the purity of chemicals for the preparation of nutrient solutions guarantee the absence of nitrates, salts of heavy metals and radionuclides, residual amounts of pesticides and plant allergens in plant products. An obligatory element of increasing the efficiency of production and energy saving in the transition to artificial substrates in new-generation greenhouses is the use of CO_2. It is established that greenhouses equipped with automated control systems for bioprocessing processes, such as seedling seedlings; light culture of plants, increase the yield of vegetable crops by more than 1,5 times. In addition, microclimate management in greenhouses using computer-aided control of parameters (phytomonitoring) allows plants to perform the required CO_2 absorption efficiency, which reduces environmental pollution by carbon dioxide.

It should also be noted that such an important technological process as covering the surface of greenhouses with film reduces the probability of penetration of soil infection into the greenhouse substrate, scales down damage to plants by pests and diseases and decreases the cost of protective equipment. Improvement of phytosanitary situation in greenhouses is also associated with the use of drip irrigation and reduced evaporation, excessive moisture is not created in the lower tier of leaves, vegetative mass and plant fruits are not getting wet, which is essential for preventing diseases and obtaining high quality crops. An important element of the technology is the application of biological and other safe methods of plant protection, as well as the use of bumblebees for pollination of plants, which were originally purchased in Israel and Belgium, currently there is a bumblebee production laboratory in the country.

In addition, the introduction of low-volume technology for vegetable cultivation in greenhouses allows solving social problems to reduce labor-intensive processes that have a low level of mechanization and automation, to improve phytosanitary working conditions, to increase labor productivity and organizational and technical level of production as a whole.

Based on the analysis of the state and identified problems, the following priority areas for further resource and energy saving development of greenhouse vegetable growing in the Republic of Belarus are recommended: continuation of technical and technological re-equipment of greenhouse vegetable growing taking into account the latest world achievements; scientific support of innovative development and introduction of the results of domestic energy and resource saving technologies into production; further improvement of the application of biologic fertilizers, drip irrigation systems and electro-illuminating plants; increase the efficiency of the use of associated heating facilities, such as natural gas, the introduction of biogas plants. In the future, greenhouse production should become a high-tech science-intensive type of economic activity with a low level of manual labor and extensive use of automated and robotic production.

Veremejchik, L. A. Nutrition, productivity and quality of tomatoes on mineral substrates in low-volume cultivation technology. Author's abstract of dissertation of doctor of agricultural Sciences: 06.01.04 / L. A. Veremejchik; Inform.-compute. center M-va Finance Resp. Belarus. – Minsk, 2008. – 41 p.